PHOTOVOLTAICS IN THE UK: **FACING THE CHALLENGE**

A Strategy for the UK to Claim a Significant Share of this Dynamic Clean Energy Industry

The British Photovoltaic Association - January 1999

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Executive Summary

The Photovoltaic Market

Photovoltaic (PV) technology converts sunlight directly into electricity without noise, pollution or harmful waste products. PV systems are easy to install and, having no moving parts, will work reliably for several decades with minimal maintenance. Power can be generated on site, where it is needed, so avoiding transmission costs and losses.

PV is cost-effective for small power requirements where there is no grid supply. This has resulted in the growth of a number of niche markets to a current value approaching £1 billion per annum worldwide. There is an enormous potential market in the developing world, where some 2 billion people have no electricity and PV is often the cheapest and most suitable power option.

In industrialised countries, PV is presently more expensive than mains electricity, but it has an important future role to play in the drive to reduce atmospheric pollution, as it is the only renewable energy technology that is suitable for electricity generation in the urban environment. PV systems can be unobtrusively integrated into the walls and roof of buildings, requiring no additional land.

The key pre-requisites for driving down system costs to make PV competitive with mains electricity are continued R&D and a market volume that will support cost-effective mass production. Several countries, including Germany, the Netherlands, Japan and the USA have initiated programmes of government investment, in collaboration with industry, to achieve this goal within the next 20 years.

British companies have approximately £100 million of today's world market (around 10% market share), but most production takes place overseas, in countries where there is a substantial government-stimulated home market and/or manufacturing costs are low. In the UK where neither of these conditions applies, the PV industry currently employs fewer than 400 people, with only two indigenous module manufacturers who produce less than 1% of the world total.

However, the UK is well placed to move into a leading position in the world market, given relatively modest government support.

The aim of the British Photovoltaic Association is to gain a 15% market penetration by 2010, including an installed UK PV capacity of 300 MWp by this date. To meet these targets, the industry will need to invest, on average, 15-20% of sales revenue to build new PV factories, amounting to over £100million in total by 2010. In that year, the benefits for the UK of this programme, if successful, would be an increase of PV sector employment to around 19,000 by British companies, a turnover of around £1.2 billion, and a reduction in CO_2 emissions of 165,000 tonnes. A strong government policy towards PV opportunities both in the UK and in international programmes is needed in order to create industrial investment confidence.

Strategy for Market Development

The PV-UK market development strategy is a four point initiative to:

- demonstrate the viability of PV technology,
- highlight and further improve UK expertise in the field,
- establish market enablement mechanisms with the objective of stimulating sustainable markets for PV products and services in the medium term, and
- increase support for research and development in line with industry priorities.

Showcase of PV Technology

Goal: To build high-profile PV exemplars showing British technology in use in Britain.

The purpose of the initiative is to:

- develop the building-integrated PV market in the UK,
- showcase British technologies and expertise,
- demonstrate PV technology to key decision-makers.

A performance indicator of the success of this initiative will be a firm commitment by the end of the year 2000, to a number of new prestige buildings. Each will integrate around 50 kWp to 100 kWp of PV, together with monitoring system, to a minimum installed capacity of 500 kWp.

The initiative would be funded through a 50% capital grant programme, at a cost to the Treasury of £3m to £4m over three years. This would be more than matched by investment from the industry itself.

Establish the UK Grid-connected Market

Goal: Establishment of institutional mechanisms to support integration of PV on UK buildings as embedded generation.

The following measures are proposed:

A. Include in future NFFO orders a limited tranche specifically allocated to PV, with premium rates of around 20p/kWh (or a combination of a lower premium rate with a capital grant). Assuming that renewables funding via the Fossil Fuel Levy (FFL) continues at about £100m per annum, it is proposed that 10% of these funds be allocated to PV.

B. Make a direct grant of 50% towards the capital cost of domestic grid-connected PV systems, totalling 2000 kWp per annum. Based on experience in Germany and Japan, this would stimulate an immediate market of at least 1000 systems per annum. The annual cost would be about £6m. It is proposed to couple this with a programme in the commercial sector.

C. Allow VAT, income tax and corporation tax relief on grid-connected PV systems, thereby cutting the cost by as much as 45%. The cost to the Treasury of this measure would be similar to that of the proposed 50% grant.

D. Classify building-integrated PV modules as plant rather than as structural components, thereby making them eligible for write-down allowance.

E Make it a legal requirement for RECs to pay the same unit price for electricity purchased from embedded PV generators as that charged to their customers. This would enable net metering to be introduced.

F Promote the simplification and standardisation of grid interconnection regulations.

G Expand the programme of PV demonstrations in schools, linked to the teaching of renewable energy.

Flagship PV Rural Electrification Programme in a Developing Country/Countries

Goal: To demonstrate sustainable PV rural electrification infrastructure in a developing country using British PV technology, expertise and finance.

Exports presently offer the greatest market opportunity for British companies and currently account for around 90% of UK PV companies' revenue. The EU has proposed a target of 500 MWp to kick start decentralised electrification in developing countries. The UK should take a lead in this objective by initiating a flagship programme to install 5 MWp of PV for Solar Home Systems, water pumping systems and rural development, in a priority developing country. An aid package of

£2-5 million would facilitate this.

Research & Development

The UK government, through the Department for Trade and Industry, spent £1million in 1997 on R, D&D in PV. Support for R&D needs to increase to

£8 million per annum, commensurate with the commitments made by industry.

The Engineering and Physical Sciences Research Council is currently funding PV research in universities through the Clean Technology Programme. This amounts to about £1 million per year for a three year period. It is proposed that the funding should be increased annually by 20% per year for the next five years.

Government Support

Market Development

Assuming that renewables funding via the FFL continues at about £100m per annum, it is proposed that 10% (£10m per year) of the FFL funds that are allocated for electricity from renewable sources should be allocated to PV. This will have a significant effect on prices, market players and industry confidence.

A moderate rooftop programme (of the order of 2000 kWp per year at the present time), coupled to a similar sized programme in the commercial sector would also attract significant investment to the UK PV industry.

The development of PV in the UK is integrally coupled to basic understanding of the technology. Promotional activities are vital in order for developers, architects, utilities, local authorities and users to differentiate between PV and solar water heating systems, and to appreciate the high tech nature of PV systems.

Following the lead of other green issues, such as recycling, PV needs to be part of the national curriculum, supported by course work and demonstrations. The Scolar Programme, launched in 1994 and supported by the DTI, will install 100 interactive PV systems in schools in the UK. This is a first step forward. Increased support for PV programmes in colleges and universities is also important for training technicians and educating the decision makers of tomorrow.

Policy support

If the proposed market development support initiatives are to achieve their maximum impact, it is vital that the policy environment is also geared to support the technology. PV-UK believes the following would facilitate more widespread technology deployment:

- VAT, income tax and corporation tax relief on purchases of PV plant,
- accelerated depreciation on PV building cladding materials,
- adoption of net metering for domestic systems,
- simplification and/or standardisation of grid inter-connection regulations.
- recognition of the value of generation plant embedded at the point of use
- specification of PV systems in aid programmes, as appropriate

PV-UK recommends the establishment of a joint implementation panel comprising members from the appropriate government bodies and PV industry. The panel would be tasked with undertaking regular planning meetings, resulting in a series of two-year implementation plans.

Resulting Benefits

The PV-UK target is to capture 15% of the world photovoltaics market, with a UK installation target of 300 MWp by 2010. This would result in:

- PV sector employment by companies based in the UK totalling around 19,000,
- the abatement of 165,000 tonnes of CO2 during that year,
- annual turnover for British companies amounting to £1.2 billion in 2010,
- more industrial players entering the market,
- the maturation of a significant high-tech environmental industry in the UK,
- significant returns to the UK in terms of exports.

The potential long-term economic and environmental benefits for the UK are clear. If we act now to create a strong and focused partnership between industry and government, Britain can capitalise on the opportunities presented by this dynamic, clean energy industry.

PV- a brief history

Photovoltaics is a remarkable technology, generating electricity directly from sunlight without moving parts and without noise or pollution.

The photovoltaic (PV) effect was discovered during the last century, but it is primarily the last twenty years that have seen major technological progress, with conversion efficiency improving by 60% and prices falling by a factor of five. Over the same period, the market for terrestrial systems has been expanding exponentially. These trends are continuing today.

The historical and immediate market for PV is in unelectrified areas of the world, particularly in developing countries. Major markets will continue to exist in these locations, but market opportunities are increasing in industrialised countries where PV is suitable for integration into roofs and building façades.

Although major British companies like BP Solar, Shell and Pilkington are among the world-leaders in the field, there is only one major manufacturer, Intersolar, producing modules in Britain. Most PV module and system manufacture is outside the UK, in countries where there is government support for market enablement. In 1997, less than 1% of the entire global production of PV modules came from the UK.

The wealth and job creation arising from the PV industry is largely located in centres where PV modules and systems components are manufactured. At present, Britain is losing out to countries which either have a substantial home market, as a result of market stimulation measures, and/or low manufacturing costs.

Introduction

Photovoltaics could be an important technology for the UK. As an energy technology manufactured from abundant natural resources, converting sunlight to electricity without gaseous emissions, and without noise, it is the ideal environment-friendly power generator.

PV is the only renewable electricity technology suitable for widespread deployment in the urban environment. It generates at the point of use, thus avoiding transmission and distribution costs.

PV technology has enormous potential to help transform the lives of some two-billion people in the developing world who currently do not have access to even basic electrical energy services.

It is an attractive solution for helping to meet rapidly increasing global energy demands, and represents an enormous export opportunity for countries at the forefront of the industry.

The technology is reliable, straight-forward to install, and simple to maintain. It is also a technology in which the UK has considerable expertise. So why does PV not have greater impact on our lives?

At present electric power generated from PV is too expensive to compete in industrialised countries with unit costs of electricity derived from fossil-fuel, nuclear or even wind. The major factor hampering progress towards competitive system costs is the size of the market - or rather the lack of it.

Several countries, including Germany, the Netherlands, Japan and the USA have initiated programmes to address this conundrum of cost versus market size. Government investment and policy, in combination with commitment from industry, is stimulating domestic markets and supporting the necessary R&D measures that will drive down system costs, and make electricity from PV cost-competitive with the retail price of electricity from conventional sources. Once these goals are achieved, which seems likely within the next two decades, these countries will be superbly positioned to move towards a competitive, secure, clean-energy future. They will also have the capacity to control the multi-billion pound world PV market.

This strategy document has been prepared by the British Photovoltaic Association (PV-UK), with support from the Department for Trade and Industry. It outlines the case and presents a strategy for industry, in partnership with the UK government, to place Britain at the forefront of this important technology and capture a substantial share of a global clean energy future.

Why PV?… Environment

One of the major drivers behind the uptake of PV and other renewable sources of energy in industrialised economies is a growing awareness of environmental problems linked to the use of conventional fossil fuels. The consensus of recent scientific opinion, including the latest findings of the Inter-governmental Panel on Climate Change (IPCC), clearly indicates that carbon dioxide and certain other gaseous emissions are contributing to a noticeable warming of the earth's atmosphere.

Climate change, and the potentially catastrophic impacts that may accompany more extreme weather patterns (droughts, floods, hurricanes and so on), are concerns for us all. It is these concerns, as well as the huge market potential, that are driving major industrial organisations - such as British Petroleum, and most recently, Royal Dutch Shell Group - to invest heavily in photovoltaics.

The insurance industry stands to suffer huge financial losses in the wake of claims for damage to property, equipment and crops due to extreme weather conditions arising from global climate change. Its key players are now calling for increased investment in environmentally benign technologies - with photovoltaics at the forefront - as the best course of action to avert global environmental catastrophe.

In Kyoto, at the Third Conference of the Parties to the UN Framework Convention on Climate Change, the European Union (EU) committed itself to a target of a 8% reduction in CO2 and other greenhouse gas emissions between 2008 and 2012 from 1990 levels. This target, as the European Parliament has acknowledged, can only be met with a very significant contribution from renewables, (particularly solar and wind), to the European Union's (EU) energy balance.

Development of renewable energy has been a central aim of EU energy policy for some time. The imperative for a greater reliance on renewable sources of energy is clearly laid out in the European Parliament's 1997 strategy document: Energy for the future: Renewable Sources of Energy, White Paper for a Community Strategy and Action Plan.

The European Parliament proposes a target of 12% of the Union’s electricity is generated from renewable sources by 2010. For photovoltaics, the White Paper proposes a target of 3 GWp installed capacity in the 15 Member States by 2010, largely provided by grid-connected building integrated systems.

The UK government's own position on the environment is in accord with EU policy. Britain's commitment to reductions in CO2 emissions were part of Labour’s 1997 election manifesto promise to "lead the fight against global warming, through …a 20% reduction in CO2 emissions by the year 2010". This target remains in place.

The government also remains firm in its commitment to increase the proportion of energy generated from renewables to 10% by 2010 from the current objective of 1500 MW Declared Net Capacity (approximately 3% of demand) by the year 2000. The longer term objective is to realise 20% renewables contribution by 2025.

As yet, there is no UK target specifically for photovoltaics, and no mechanisms to bring about large-scale deployment.

Why PV?… Security

The United Kingdom has been blessed with rich veins of high quality coal, which helped power the nation to economic prosperity during the industrial revolution. In more recent years, sizeable reserves of offshore oil and gas have helped the UK maintain that prosperity. Nuclear power was seen as the limitless source of cheap and safe energy that would see Britain forge onwards into the next millennium.

The Conservative administration's downsizing of the "uncompetitive" national coal industry during the early 1980s substantially reduced British mining. Acid rain and global warming have seen the electricity generators turn towards cheaper and/or less polluting imports from Australia, South Africa and South America, or switch to gas as a shortcut to help meet more stringent environmental targets.

But the "Dash for Gas" is not a guaranteed long-term solution: energy demands are increasing while North Sea reserves, unless there are significant new discoveries in the interim, could begin to deplete within two decades. As a result, the UK may increasingly look to imports for much of its gas and coal needs in the medium-term. The global energy market today is vastly different to that in the early 1970s, so the UK need no longer seek to become self-sufficient. Nevertheless, PV-UK believes that it is prudent to consider alternative fuel and energy sources which can help the UK maintain a degree of energy autonomy.

Nuclear power has proved itself to be neither cheap nor without risks, and majority public opinion is opposed to further development. The Labour government has committed itself to decommission the UK's nuclear power stations.

So Britain is faced with two alternatives: either resorting to increasing primary energy imports, or placing more emphasis on developing indigenous energy resources.

In the long term, other secure and sustainable "surprise" technologies may be developed, capable of contributing to our demand for power. However, renewable energy technologies represent the only real alternative achievable with current technology.

PV technology is capable today of providing the UK with a vast non-strategic supply of electricity, sufficient to meet almost two-thirds of our annual electricity demand1,2. Careful investment in this industry is driving down the technology costs to the extent that PV generated electricity will be competitive with conventional power within ten to fifteen years3.

Britain must act now to secure its capabilities in PV, and secure its power for the future.

Why PV?… Growth Industry

During the past decade, the global PV market has been expanding at between 7% and 43% per annum. The average rate has been around 15% per annum. However, in 1997 PV shipments escalated to 126.7 MWp, a 43% increase on the previous year. In 1998, shipments rose 28% to 160 MWp. This unprecedented growth has helped to stimulate increased investment in manufacturing facilities, particularly in Japan and the USA.

From 1990 to 1994, the major applications for PV were remote power (about 40%), leisure and consumer devices (about 20%), communication stations (about 25%) and grid-connected embedded generation (about 10%)4. It is predicted that by 2010 the market for PV systems will have altered dramatically, being dominated by Solar Home Systems (providing power to rural houses in the developing world) and grid-connected (building integrated and larger centralised power stations) sectors.

The value of today's PV market is about £400 million per annum in module sales. Taking into account the whole system cost from design to installation, the world market is estimated to be close to £1 billion per annum.

The “business as usual” scenario for PV market growth (15% per annum) suggests that by 2010 the PV generating capacity installed worldwide will have increased fivefold to 3400 MWp, and annual production will be about 750 MWp/year. With the reduction of market barriers, stimulation of the market through programmes of support and concerted marketing actions, and achievable reductions in system costs, it is believed that a 30% annual market growth rate is possible. Certainly, if the EU is to reach its target of 3 GWp installed capacity by 2010, growth rates will need to be significantly greater than “business as usual”.

The EU White Paper estimates that world annual module production by 2010 will be of the order of 2.4 GWp/year. This would require consistent annual growth of over 25% in line with growth rates over the last two years.

At this level of production, it is estimated that the value of PV business worldwide will be in excess of £8 billion per annum, with associated employment totalling over 440,000 people5.

Is Britain falling behind?

At first glance, the UK PV industry appears to be faring well against stiff competition from overseas. Between 1993 and 1998, UK companies increased their share of the total world PV module production market from 7% to around 10%. Annual turnover from the photovoltaics sector for UK based/owned companies amounted to around £100 million.

However, closer inspection shows a different picture:

- the majority of UK companies' cell and module production actually takes place in Spain and Australia,
- the UK has only one major indigenous module manufacturer, producing approximately 1 MWp (less than 1%) of the annual world total,
- the total number of people employed in the entire PV sector in the UK is less than 400.

This should not be taken to mean that British companies do not want to invest in the UK, on the contrary, but at present the incentives to establish manufacturing facilities overseas are too great to reject. It is noticeable that, no foreign companies have chosen to inwardly invest in PV manufacturing in the UK, to date. This is largely due to the virtual absence of a local market for PV, and a lack of a strategy to address the situation.

Nevertheless, UK industry is well placed to move into a leading position in the world market, having a wide base of expertise in complementary areas across the breadth of the industry. In the UK, there are leaders in both high-efficiency crystalline silicon and lower cost thin-film cell technologies. Industrial activities are linked to university research co-operation. The UK is home to world-leading companies in cell production equipment, systems design and installation, and consultancy. There is strength in manufacturing balance-of-systems components such as inverters, lights and electronic ballasts. In the key areas of rural electrification and PV in buildings, PV-UK organisations have considerable expertise to take the industry into the next century.

The British PV industry is actively seeking to capture a far greater share of the world market. A 15% market share is an achievable medium term objective, given appropriate investment by the PV industry and government. Traditional UK links with overseas countries, including the Commonwealth, make a strong foundation for such commerce. To achieve a 15% market share against global competition (particularly from Japan and the USA) requires (i) a growth strategy and associated business plan, and (ii) a real partnership and commitment between industry, academia and government.

But why should Britain invest in PV? In other European countries - Austria, Germany, the Netherlands, Switzerland, even Sweden - PV is making a sizeable contribution to electricity demand. A typical 3 kWp domestic system, installed in Europe, Japan or the USA, should meet two-thirds of the annual average domestic electricity demand.

A number of demonstrations show that PV does work here. In Oxford, a 4 kWp system on a detached family house generates more electricity annually than the family uses. The excess is sold to the local electricity company. In Newcastle, a 40 kWp building-integrated PV system, installed in 1994 during renovation of an office block at the University of Northumbria, provides some 23,000 kWh of electrical energy annually6. In fact, the UK has numerous PV systems providing electricity for homes, industry and offices. There are also several thousand PV systems powering devices such as navigation buoys, telephone boxes, weather monitoring stations, automatic railway track greasing equipment and so on.

These are a fraction of a potentially enormous market. A 1992 report7 estimated that the wholesale application of PV onto the available sun-facing surfaces of UK building stock could generate 208 TWh of electricity each year with present day technology. That is 63% of the UK's 1995 consumption.

Though not yet cost-effective in terms of unit energy costs (p/kWh) for grid-connected applications in the UK, PV is increasingly competitive as a building component. It is considerably less expensive today than other prestige cladding materials. As costs fall further, it may compete with conventional glass cladding systems.

In 1995 PV-UK, co-funded by the EC Altener programme and the UK-Department of Trade and Industry (DTI), initiated the Information Action Photovoltaics in Buildings (PViB) project, to raise awareness in the UK building industry about the potential for incorporating PV technology into buildings. This stimulated an increasing number of enquiries from developers and architects keen to employ PV in their designs.

…while the rest move on

In contrast to the UK, the USA, Japan, Germany, the Netherlands and Switzerland have each initiated ambitious programmes aimed at boosting indigenous expertise in PV technology. The rationale behind these programmes may not be directly applicable to the UK (Japan, for instance, has no indigenous fuel resources, and has higher electricity prices). Nevertheless, each country is expecting to gain a strategic foothold for future export market expansion. In each case, the main prerequisite for achieving this is a domestic market that gives the PV industry confidence to invest in manufacturing capacity and expertise.

Although these markets are not closed to UK companies, there is a definite competitive advantage for manufacturers that are established in-country. With a guaranteed local market, these manufacturers face a lower investment risk in increasing their production capacity which allows real volume savings to be made. This is the key to breaking the chicken and egg conundrum wherein system costs must drop for sales volume to increase substantially, but for cost reductions to be achieved a sizeable market is essential.

The German government has invested seriously in PV R & D and installation, over the last eight years. Under its Fourth Programme on Energy Research and Energy Technology, it has three clear objectives, namely:

- the reduction of CO2 emissions,
- the modernisation and safeguarding of its industrial base through the development of new technologies and expertise, and
- the promotion and introduction of environmentally friendly energy technologies with economic and technical potential.

For PV the specific goals are to establish it as a real, competitive energy technology; to accelerate technology developments that will be transferred to the production-line; and to support and expand the niche markets that already exist.

The German government has deployed a combination of measures including a substantial R&D budget, direct Federal investment subsidies and favourable credit terms for purchasers of PV systems, coupled with demonstration projects to confirm the feasibility of the technology. This has roused public interest, and has catalysed further regional / local government and utility actions to increase PV installation momentum based on strong public support for the technology.

During the five years to 1996, Germany's installed PV capacity quadrupled to

23 MWp, and by the end of 1997 a further 10 MWp was installed. The positive environment for PV R,D&D has enabled German manufacturers of ancillary equipment and systems integration specialists to establish themselves as world leaders.

However, during the mid 1990's, even Germany's major manufacturers, in the light of attractive financial incentives (most notably from in the USA), migrated to establish production overseas. Market opportunities in Germany today are now helping to draw in new manufacturing investment: ironically, Pilkington Solar, a subsidiary of Pilkingtons plc, announced in November 1997 that it was co-operating with the Royal Dutch Shell Group to establish the world's biggest cell manufacturing plant, producing 25 MWp of multicrystalline silicon cells per year, in Gelsenkirchen, Germany. Public funds, meeting nearly half the cost, helped to attract this development.

Why should Pilkington, or for that matter BP, both major British companies choose to establish their manufacturing facilities outside the UK? The base of PV expertise in Britain across the board from basic research and module manufacture, to ancillary technologies and consultancy, is as strong as anywhere in the world. The reason is clear: Britain has no home market to showcase its expertise, and incentives to develop this market are minimal. As a result the UK continues to lose out to the competition.

With three of the world's biggest economic powers already committed to programmes aimed at driving down the costs of PV systems, so that convergence with the price of conventional power becomes a reality, the future of photovoltaic technology is assured. Britain has to make a choice: act now and claim a share of a business opportunity expected to exceed £60 billion within twenty to thirty years: or watch other countries reap the benefits from a technology which British companies have helped to nurture.

The Challenge

Other countries are investing today in creating the facilities, skills and environment that will offer them a sustainable, clean and secure power supply for the future. This investment in photovoltaics is building a high technology industry, with massive job creation and income generation potential through export and home market business.

The British PV industry is actively seeking to capture a far greater share of the total world market . PV-UK believes that a 15% share is an achievable medium term objective, given appropriate investment by the PV industry and government. Traditional UK links with overseas countries make a strong foundation for such commerce.

To achieve a 15% market share against global competition (particularly from Japan and the USA) requires (i) a growth strategy and associated business plan, and (ii) a real partnership and commitment between industry, academia and government.

The challenge to the UK is clear: to claim a share of this future, we must act today to build up our national capabilities in this field, and address the issues that need to be resolved if the UK is to realise its full potential.

Costs

PV is already cost-competitive for small off-grid applications, with the major markets being in the un-electrified areas of the world - principally developing countries.

Efforts to stimulate new markets for PV in the UK and other "electrified" countries mainly revolve around addressing the cost barrier. As PV markets and production increase, unit costs will continue to fall. This is partly due to improvements in yields and manufacturing techniques, but mainly due to the economies-of-scale in larger production plant.

A recent study8 undertaken for the European Commission by the main players in the European PV industry demonstrated that significant up-scaling of PV manufacturing plant production capacity (to 60 MWp/year for thin-film production, or 200 MWp per year for crystalline silicon) will enable module costs to be reduced by 75 to 80% from current levels. With achievable cost breakthroughs in balance-of-systems components (inverters, support structures etc.) and installation (which will occur as installing a system becomes less specialised), the unit cost of electricity generated from PV will converge with the price of electricity generated from conventional sources.

A study9 undertaken by PV-UK revealed that, at module costs of 0.8ECU/Wp [65p/Wp] (the target cost achieved by up-scaling plant), unit electricity costs from PV roofs and façades in the UK and throughout Northern Europe fall to the price range of other renewable technologies when they entered the UK Non Fossil Fuel and Renewable Energy Obligations (i.e. below 12p/kWh). In Southern Europe which has higher sunlight levels, costs fall as low as 5.5p/kWh. Based on market growth predictions, it is believed that these reductions will occur within two decades. In the longer term (beyond 2020) costs will converge still closer to the price of fossil fuel electricity.

PV cladding is already less expensive to install than prestige forms of conventional cladding. As PV cladding prices continue to fall, with standardisation of components, improved installation procedures and experience, such façades will compete with other forms of cladding. Then the value of the electricity will not be the only incentive to the buyer and the market will grow rapidly.

As noted already, stand-alone PV for many rural and remote applications is economic today compared to diesel generation or grid extension in a wide range of applications both in industrialised and developing countries. As module costs fall, the range in which stand-alone PV is economic will increase still further.

Central PV generating stations will also become more economic in Southern Europe, the US and other sunny regions, with costs expected to converge to about 11-12p/kWh in the medium term. In cloudless locations, PV concentration of sunlight will be important.

Market Stimulation

As PV is already cost competitive for off-grid applications in most parts of the world, immediate market expansion can be achieved in non-electrified areas, particularly developing countries for applications as diverse as large telecommunications systems to small (30 Wp) Solar Home Systems. These markets will grow even without efficiency improvements and cost reductions. However, this process would be greatly aided by targeted programmes to raise awareness amongst consumers, and particularly by the establishment of appropriate credit facilities and sales, distribution and servicing outlets.

Standards

Considerable effort is being put into the development of international standards for PV products. This international co-operation requires long lead times to establish a consensus on even the smallest of issues. However, it is vital that quality standards for PV modules, systems, components and so on, are established to give reassurance to customers on system performance and safety issues.

UK representatives, through the British Standards Institution (BSI) Committee GEL82 and International Electrotechnical Commission (IEC) Committee TC82, played an important role in the preparation of international PV standards from 1982 to 1990. In 1996 PV-UK negotiated with the BSI to re-establish GEL 82. The UK now actively participates in IECTC 82 and CENELEC BTTF 82, which are establishing new standards for small stand-alone systems, for components and for PV on buildings. The UK also has representation in the Global Approval Programme for PV. PV-GAP is an international, industry-driven initiative to promote and maintain quality PV standards and certification procedures for the performance of PV products and systems. It complements the work of the IEC.

Technical Acceptance

PV systems have been performing satisfactorily for many years in a variety of applications. The challenge now is to achieve full technical acceptance in grid-connected applications. For this, utility companies will be the key players.

The Environment

Within the UK, every square metre of PV installed on a south facing building will, in the 20 year lifetime of fossil fuel plant, displace about one tonne of CO2 emissions. Moreover, the lifetime of PV modules can be over 20 years. PV is ideally suited to applications in building projects where energy conservation and environmental acceptability are key issues.

Encouragement at all levels to promote the use of PV, particularly in the built environment, are entirely appropriate under the "CO2 saving" banner.

Education and Training

Education and training are needed for all aspects of PV technology in schools, colleges and universities. The Scolar Programme, launched in 1994 and supported by the DTI, will install 100 interactive PV systems in UK schools. This is a first step forward.

Several UK universities have initiated postgraduate programmes in renewable energy, with opportunities for specialisation in PV. An expanding market requires graduates familiar with the science and technology of PV.

There are very few training courses for PV systems installers, electricians or associated trades. To ensure that systems are installed to a satisfactory standard, taking full account of appropriate buildings and electrical safety regulations, and in order to satisfy the anticipated growth in the market, particularly for building integrated embedded PV generators, accredited courses for these trades people are essential.

A strategy for the UK

The British Photovoltaic Association is committed to building a strong PV industry in the UK. Its members aim to achieve this by progressing present technologies, developing new processes and products, reducing costs, and investing in manufacturing capacity to meet market demands. But it is difficult to realise these objectives without full government co-operation.

PV-UK recognises that the UK internal market for PV will always be a very small proportion of the global market, with most of the opportunities for increased wealth and job creation derived from exports. However, it is critical for encouraging PV module manufacturing in the UK, for encouraging inward foreign investment, and for showcasing British expertise, that a buoyant home market be established.

Working with negligible profit margins, the industry is not in a position to sell systems at the substantially lower price needed to make PV electricity competitive today with conventional power. However, system costs, and hence unit energy costs, could be brought down dramatically given a significantly larger market and focused R&D.

It is not foreseen that PV will compete with Electricity Pool prices in the short to medium term, but with support from government and the electricity supply industry, a market for PV integrated into buildings as embedded generation to offset consumer grid purchases, could be developed. Initially, this would be mainly on prestige commercial buildings, where the developer is keen to make a "green" statement, and on domestic installations owned by environmentally minded householders.

PV-UK strongly believes that domestic manufacture of modules is integral in developing the British PV industry. Experience from the USA and Japan in particular supports the view that a strong module manufacturing capability leads to spin-off developments in balance-of-systems (BOS) component industries such as inverters, batteries, integration technologies etc. BOS components constitute approximately 50% of the industry's value globally.

In order to achieve the PV-UK goal of a 15% share of the total world market by 2010, it is estimated that on-line manufacturing capacity in the UK will need to approach 300 MWp/year.

As an indication of the UK's commitment to this technology, the Association recommends that a target for installed capacity of 300 MWp10 by 2010 be adopted.

The PV-UK market development strategy is a four point initiative to:

- demonstrate the viability of PV technology,
- highlight and further improve UK expertise in the field,
- establish market enablement mechanisms with the objective of stimulating sustainable markets for PV products and services in the medium term, and
- increase support for research and development in line with industry priorities.

SHOWCASE PV TECHNOLOGY

Goal: to build high-profile PV exemplars showing British technology in use in Britain.

The purpose of the initiative is to:

- develop the building-integrated PV market in the UK,
- develop indigenous manufacturing of modules and BOS components,
- demonstrate British technologies and expertise to potential customers (from home and abroad), and
- demonstrate PV technology to the decision-makers of tomorrow.

A performance indicator of the success of this initiative will be a firm commitment by the year 2000, of a number of new prestige buildings. Each will integrate around 50 kWp to 100 kWp of PV, together with monitoring system, to a minimum installed capacity of 500 kWp. It is desirable that each will incorporate, as far as possible, British PV products. The initiative would be funded through a 50% capital grant programme,

at a cost to the Treasury of £3 to £4 million over three years. This would be more than matched by investment from the industry itself.

PV-UK recognises that subsidies based on system capacity do not necessarily guarantee optimum energy production. However, as a market initialisation measure, and assuming that adherence to certain technical and safety principles would be a pre-requisite for qualification for support, subsidies are regarded as the simplest and most effective near-term measure to stimulate the market.

ESTABLISH THE UK PV GRID CONNECTED MARKET

Goal: establishment of institutional mechanisms to support integration of PV on UK buildings as embedded generation.

Market stimulation, by regulations and other government instruments, are needed to assist in the development of the UK grid connected market. Such instruments might include modified obligations on RECs to accept PV generated power, rate-based incentives and/or capital allowances. A range of measures regarding fair access for renewable energy technologies to the electricity market, and possible fiscal and finance support are detailed in the EU White Paper.

PV-UK recognises that the Obligations (NFFO, SRO, NIO) for UK RECs to buy electricity from renewable energy suppliers is related to the national need for diverse, secure and "clean" supplies, and to the international agreements to reduce carbon dioxide emissions from fossil fuels. There is also the assumption that costs will reduce to be competitive with nuclear and fossil fuel generation, especially coal and gas. However, external costs on society for nuclear and fossil fuel emissions are not charged to those sources, and the benefits of embedded generation on the grid are not all credited to the embedded source (e.g. relief from triad charges). This discriminates against PV installations, as well as other renewable energy electricity generating technologies.

The following specific measures are proposed:

A. Include in future NFFO orders a tranche specifically allocated to PV, with premium rates of around 20p/kWh (or a combination of a lower premium rate with a capital grant). Assuming that renewables funding via the Fossil Fuel Levy continues at about £100 million per annum, it is proposed that 10% of these funds be allocated to PV.

B. Make a direct grant of 50% towards the capital cost of domestic grid-connected PV systems, totalling 2000 kWp per annum. Based on experience in Germany and Japan, this would stimulate an immediate market of at least 1000 systems per annum. The annual cost would be about £6 million. It is proposed to couple this with a programme in the commercial sector.

FLAGSHIP DEVELOPING COUNTRY PV RURAL ELECTRIFICATION

Goal: to demonstrate sustainable PV rural electrification infrastructure in a developing country(s) using British PV technology, expertise and finance.

Exports presently offer the greatest market opportunity for British companies, currently accounting for around 90% of UK companies' PV revenue. The key markets for photovoltaic technology are to satisfy basic electrification requirements in remote and rural areas of less developed countries . The market for household electrification, water pumping, health, education and communications services is estimated to amount to 17 GWp11, with the biggest single market, solar home systems, accounting for two-thirds of this total. These are applications where PV is already cost effective. Although a real potential market of the order of £150 billion exists today, awareness, financing and support infrastructure all must be addressed if this is to be realised.

The majority of industrialised countries provide aid to developing countries. All but one of the major players have supported PV pilot and demonstration projects, the exception being the UK. Such aid programmes make a vital contribution to the standard of living in developing countries. They also benefit the donor's PV industry.

Bilateral aid funding worldwide amounts to more than £30 billion. The largest donor, Japan, which annually provides around £8 billion has announced through its Kyoto Initiative an emphasis on renewable energy,

and is currently seeking to identify PV co-operation projects. Australia is currently financing two major PV projects in Indonesia and the Philippines with more than $20 million which greatly supports its domestic PV manufacturers (including BP Solar Australia).

The World Bank Group and Global Environment Facility are currently providing grants and concessional loans, totalling around £700 million for renewable energy projects, with PV as a major component.

The purpose of the proposed initiative is to take the lead on one or more developing country programmes which require not just PV technology but also the seeding of sustainable markets. This will require collaboration with national and international agencies such as the Department for International Development, World Bank, International Finance Corporation, Global Environment Facility, and the development Directorates of the European Commission. The result would be a substantial project in major countries with potential markets such as India or China.

Proposing suitable projects is complex, given that any such initiatives have to fit in with the recipient country's own electrification and development strategies, and depend heavily on the status of its technical and financial infrastructure development.

The EU has proposed a target of 500 MWp of PV to kick-start decentralised electrification in developing countries. The UK should take a lead in this objective by initiating a flagship programme to install 5 MWp of PV for Solar Home Systems, water pumping systems and rural development, in a priority developing country. A national aid package of £2-5 million would help facilitate this project.

Research and Development

PV is a relatively new technology and so research and development are critical to establishing a market lead.

This will strengthen ongoing research on: improving system efficiencies and improving methods of production; cell materials; and BOS systems and modules for building integration, grid interaction and stand-alone systems.

In the areas of basic cell and module technology, further efficiency breakthroughs in high efficiency crystalline silicon cells and modules should continue to be pursued. The cost benefits of thin-film technologies may be further enhanced by R&D into cadmium telluride and multi-junction thin-film amorphous silicon.

R & D funding for the development of systems components is vital in order for the UK to capture a larger share of this lucrative section of the PV market. Systems for building integration and grid interconnection, including the development of inverters and AC modules, should be given highest priority, again with the objective being cost reduction of total systems, including installation.

As part of continued support for R & D, important programmes (such as the International Energy Agency (IEA) Photovoltaic Power Systems Programme), which promote international collaboration, should continue to be funded.

The Way Forward

PV-UK is seeking to develop a strategic alliance between the PV industry, UK government and other relevant actors, with the objective of nurturing an environment in the UK which will result in investment being made here, ahead of abroad. PV-UK envisages a UK agreement similar to that of the Netherlands where industry, government, utilities and implementing agencies have signed a 'PV Covenant'12, agreeing objectives, roles and a timetabled implementation strategy to establish the Dutch domestic market and gain a strong foothold in the global PV environment.

Commitment by all parties to the measures of support proposed below would result in a significant expansion of UK PV manufacturing capacity, which is essential if UK plc. is to realise the benefits of rapid growth of the global PV market. Since the UK internal market for PV will always be a very small part of the global market, most opportunities for wealth and job creation will derive from exports.

The following sections outline the inputs required from the key players.

Inputs from the British PV Industry

In order to supply the quantity of PV modules suggested by the PV-UK projection, considerable investment will be required in module manufacturing. To maintain 15% of the PV-UK world market growth scenario, the UK industry will need, on average, to invest over 15%-20% of sales revenue in developing new manufacturing capacity, amounting to over £100 million in total by 2010. This investment will come from the industry itself.

In addition, the balance of systems components industry will be expanded with the increased share of the module market as UK module manufacturers source system components locally.

Inputs from Government

Research & Development

The UK government, through the Department for Trade and Industry, spent £1 million in 1997 on PV Research, Development and Demonstration (R, D & D). Support for R & D needs to increase to £8m per annum commensurate with the commitments made by industry. Wherever possible, these funds should be used to leverage additional funding from European sources.

The Engineering and Physical Sciences Research Council (EPSRC) is currently funding PV research in universities through the Clean Technology Programme. This amounts to about £1 million per year for a three year period. It is proposed that EPSRC funding should be increased annually by 20% per year for the next five years.

The Office of Science and Technology is providing £1 million over three years (through EPSRC) for the Scolar Programme. It is important that industry, DTI, EPSRC and OST support and activities are closely co-ordinated.

Support for Market Development

The funding to enable purchase of PV electricity by the RECs at higher than normal rates is already collected via the existing Fossil Fuel Levy (FFL). The amount of the FFL directed towards renewables has risen over the past 5 years to £96m in 1994-95.

Assuming that renewables funding via the FFL continues at about £100m per annum, it is proposed that 10% of the FFL funds that are allocated for electricity from renewable sources should be allocated to PV. This would amount to £10m per year. It is likely that payments for electricity at 20p/kWh would stimulate PV investment, e.g. for PV building cladding where there are other benefits to the owner. Further work is needed to identify the most effective method of using this fund, as touched upon in the previous chapter.

A moderate rooftop programme (of the order of 2000 kWp per year at the present time), coupled to a similar sized programme in the commercial sector would also attract significant investment to the UK PV industry.

Policy support

If the proposed market development support initiatives are to achieve their maximum impact, it is vital that the policy environment is also geared to support the technology. PV-UK believes the following would facilitate more widespread technology deployment:

- VAT, income tax and corporation tax relief on purchases of PV plant,
- accelerated depreciation on PV building cladding materials,.
- adoption of net metering,
- simplification and/or standardisation of inter-connection regulations
- recognition of the value of generation plant embedded at the point of use,
- specification of PV systems in aid programmes, as appropriate.

PV-UK recommends the establishment of a joint implementation panel comprising members from the appropriate government bodies and PV industry. The panel would be tasked with undertaking regular planning meetings, resulting in a series of two-year implementation plans.

Input from the electricity utilities and OFFER

PV-UK recognises the central importance of the co-operation of the regional electricity companies (RECs) for the acceptance of PV embedded generation. The Office for Electricity Regulation (OFFER) is able to advise on regulations for fair trading of electricity. All the technical requirements for safe and secure import of PV electricity into the grid can be met; there are many thousand such installations world-wide. The electricity produced at the consumer's property in the daytime both offsets the consumer's purchase of electricity from the grid and allows excess power to be exported. Both factors can be an asset to the REC, especially on limited capacity grids, and to avoid the generation of central peaking power. PV-UK recommends that OFFER be involved in deciding on fair prices for electricity purchased from embedded PV generation.

The Role of DFID

The Department for International Development provides around

£2 billion per annum of international aid. There is a DFID R & D programme which includes small funding for PV (£0.05m/year) but there have been no significant bilateral PV projects.

PV is often the most cost-effective power source in unelectrified areas, bringing services that would otherwise be denied and playing a crucial role in poverty alleviation. The sectors affected include agriculture, healthcare, education, micro-enterprise development emergency aid and community development. PV-UK believes that there would be significant advantages for the British PV industry, if PV systems were incorporated, as appropriate, as a “matter of course” with DFID projects. DFID funding could also be used to support and showcase electrification projects, where the aims included poverty alleviation and local development.

What benefit for UK plc?

The PV-UK target is to capture 15% of the world photovoltaics market, with a UK installation target of 300 MWp by 2010.

The quantifiable benefits accruing to the UK as a result of the PV-UK strategy will be achieved in three key areas: employment, environment and wealth creation.

Employment

Market expansion at the rate required to achieve the EU White Paper target (over 25%), projects a total PV sector employment in 2010 of 440,000 .

With a UK market share of 15%, and assuming that the target of 300 MWp installed in the UK by 2010 is achieved (equating to around 3% of the total world capacity in 2010), PV sector employment by UK companies is estimated to total approximately 19,000 by 2010. This includes staffing requirements for construction of new manufacturing plant, module production, BOS production, and related services, as well as retailers, installers and maintenance staff. Additional employment relating to the shipment of UK products will be generated in the areas of destination outside the UK for retail, installation and maintenance services.

Environment

By 2010, the UK government aims to achieve a 20% reduction in emissions of CO2 compared to 1990 levels. It is estimated that adoption of the PV-UK proposed installation target would result in the abatement of 165,000 tonnes of CO2 in 2010. This is equivalent to 0.1% of the 1990 total CO2 emissions from all sources and across all usage-sectors.

Wealth Creation

If the UK is successful in capturing the PV-UK target of 15% of the world market by 2010, the annual turnover for British companies is expected to amount to £1.2 billion by 2010. This will be spread across the breadth of the industry: manufacturing, consulting, installing, R & D.

A significantly expanded UK home market will lead to new players entering the market. Depending on the partnership developed between industry, academia and government, these new entrants are once again expected across the industry. Due to the nature of PV manufacturing and installation, it is expected that many of these will be small and medium sized businesses, bringing employment and wealth at a local level.

The British Photovoltaic Association

PV-UK, the British Photovoltaic Association, was formed in 1991 to advance the development and use of photovoltaics (solar electric systems). The Association actively promotes the use of PV within the United Kingdom, as well as in other regions such as Africa, Asia and Latin America. PV-UK is a non-profit organisation, and has strong ties with other organisations involved in sustainable development.

PV-UK members are drawn from industry, universities and consulting practices, and many are world leaders in their field. They include manufacturers and suppliers, R&D organisations, consultants, academics, electricity suppliers and installers. Members of the Association range in size from one-person operations to large international companies.

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